

## APPENDIX C

## SEAOC AMENDMENTS TO ACI 318

**C-1.** The following amendments to ACI 318-89 are compatible with the 1990 SEAOC recommendations.

**C-2.** Add the following provision:  
Plain concrete shall not be used for structural members of buildings in Zones 2, 3, and 4.

**C-3.** In ACI 21.1, add the following definitions:

- a. *Confined core.* The area within the core defined by  $h_c$ .
- b. *SMRF.* Special moment resisting frame conforming to the provisions of ACI 21.1 through 21.7, as they apply to moment resisting frames.
- c. *Seismic hook.* A 135-degree bend with an extension of six bar diameters, but not less than 3 inches, that engages the longitudinal reinforcement and projects into the interior of the stirrup or hoop.
- d. *Wall pier.* A wall segment with a horizontal length-to-thickness ratio between 2.5 and 6, whose clear height is at least two times its horizontal length.

**C-4.** In ACI 21.1, add the following definition of design load combinations:  
The load factors given in ACI equations 9-2 and 9-3 shall be modified to

$$U = 1.4(D + L + E)$$

$$U = 0.9D + 1.4E$$

**C-5.** Add to ACI 21.2.4.2:  
In no case shall the compressive strength of lightweight concrete used in design exceed 6000 psi.

**C-6.** Add to ACI 21.3.3.4:  
Stirrups shall have seismic hooks.

**C-7.** Add to ACI 21.4.1:  
The requirements of this section also apply to all members resisting gravity loads by compression.

**C-8.** Add to ACI 21.4.1:  
Any area of a column which, for architectural purposes, extends more than 4 inches beyond the confined core shall have minimum reinforcing as required for nonseismic columns as specified in 21.8.

**C-9.** Add to ACI 21.4.3.2:  
Tension splices shall be proportioned as Class A tension splices in accordance with chapter 12 and shall have transverse reinforcement over the full lap splice length in accordance with 21.3.2.3.

**C-10.** Add to ACI 21.4.4.4:  
Where the calculated point of contraflexure is not within the middle half of the member clear height, provide transverse reinforcement as specified in 21.4.4.1 through 21.4.4.3 over the full height of the member.

**C-11.** Replace the last sentence of ACI 21.4.4.5 with the following:  
If the column terminates on a wall footing or mat, transverse reinforcement as specified in 21.4.4.1 or 21.4.4.3 shall extend into the footing or mat either the compressive development length of the largest longitudinal reinforcement or the lead length of a standard hook.

**C-12.** Add to ACI 21.4.4:  
At any section where the ultimate capacity of the column is less than the sum of the shears  $V_u$ , computed in accordance with 21.7.1.1 for all the beams framing into the columns above the level under consideration, transverse reinforcement as specified in 21.4.4.1 through 21.4.4.3 shall be provided. For beams framing into opposite sides of the columns, the moment components may be assumed to be of opposite sign. For the determination of ultimate capacity of the columns, these moments may be assumed to results from the deformation of the frame in any one principal axis.

**C-13.** Add to ACI 21.5.2.4:  
Splices in horizontal reinforcement shall be staggered. Splices in two curtains, where used, shall not occur in the same location.

**C-14.** Add to ACI 21.5.2:  
Where boundary members are not required by 21.5.3.1, minimum reinforcement parallel to the edges of all shear walls and diaphragms and boundaries of all openings shall consist of twice the cross-sectional area of the minimum shear reinforcement required per lineal foot of wall.

**C-15.** Add to ACI 21.5.2:  
Transverse reinforcement terminating at the edges of shear walls without boundary elements shall have a standard hook engaging the edge reinforcement, or the edge reinforcement shall be enclosed in 'u' stirrups of the same size and spacing and shall be spliced to the transverse reinforcement.

*EXCEPTION:* Walls with a factored shear,  $V_u$ , in the plane of the wall less than  $A_{cv} \sqrt{f'_c}$  need not meet these requirements.

**C-16.** Add to ACI 21.5.3:

Structural steel members conforming to SEAOC Chapter 4 and encased monolithically in the walls at the edges may be used for boundary members provided adequate shear transfer is provided between the steel and the concrete.

**C-17.** Add to ACI 21.5:

A cast-in-place topping on a precast floor system may serve as the diaphragm provided the cast-in-place topping acting alone is proportioned and detailed to resist the design forces.

**C-18.** Add to ACI 21.5:

Minimum thickness of diaphragms. Diaphragms used to resist prescribed lateral forces shall not be less than 2 inches thick. Topping slabs placed over precast floor and roof elements shall not be less than 2½ inches thick.

**C-19.** At the end of ACI 21.5, add a new section: Wall piers.

*a.* Wall piers not designed as part of a SMRF shall have transverse reinforcement designed to satisfy the requirements of paragraph b below.

*EXCEPTION 1.* Wall piers that satisfy ACI 21.8.

*EXCEPTION 2.* Wall piers along a line within a story where other shear wall segments provide lateral support to the wall piers and such segments have a total stiffness at least six times the sum of the stiffnesses of all wall piers along that line.

*b.* Transverse reinforcement shall be designed to resist the shear forces determined from ACI 21.7.1.2 and shall meet the requirements of ACI 21.7.2.1. When the axial compressive force, including earthquake effects, is less than  $A_g f_c' / 20$ , transverse reinforcement in wall piers may have standard hooks on each end in lieu of hoops. Spacing of transverse reinforcement shall not exceed six inches. The zone of transverse reinforcement shall be

extended beyond the wall pier clear height for at least the development length of the largest longitudinal reinforcement in the wall pier.

*c.* Wall segments with horizontal length-to-thickness ratio less than 2½ shall be designed as columns.

**C-20.** Add to ACI 21.6.1:

Where longitudinal beam reinforcing bars extend through a joint, the column depth in the direction of loading shall not be less than 20 times the diameter of the largest longitudinal bar.

**C-21.** In ACI 21.7.1.3, change the specification of load combinations from 9.2 to paragraph C-4.

**C-22.** Add to 21.7.2.1:

Earthquake-induced shear force is the shear induced by the flexural moment strengths of the beams calculated in accordance with 21.7.1.1.

**C-23.** Delete ACI 21.7.3.1.

**C-24.** Revise the title of ACI 21.8 to read:

Frame members not part of the lateral force resisting system.

**C-25.** Delete ACI 21.8.1 and substitute the following:

All frame members assumed not to be part of the lateral force resisting system shall be shown to be adequate for vertical load carrying capacity with the structure assumed to have deformed laterally in accordance with SEAOC 1H2d. Such members shall satisfy the minimum reinforcement requirements specified in 21.3.2.1 and 21.5.2.1 and chapters 7, 10, and 11.

**C-26.** In ACI 21.9.3, delete the word “factored” in reference to “gravity loads.”